Virginia Response and Action Plan for Asian Soybean Rust[1]

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Introduction

The purpose of this plan is to outline actions for the pre- and post-confirmation of the establishment of Asian Soybean Rust (*Phakopsora pachyrhizi*) in the United States and Virginia. Preparing for soybean rust before it is confirmed, is essential to: 1) reduce critical lost time due to the "fear factor" once rust is confirmed; 2) reduce the response time between initial confirmation and deployment of crop advisors, agronomists, and seed professionals to assess the risk of crop loss; and 3) reduce the response time between initial confirmation and employment of mitigation efforts.

This document serves as a guide for public and private stakeholders in Virginia concerning the detection, response and management of Asian Soybean Rust.

Asian Soybean Rust Background

Asian soybean rust is an aggressive fungal disease that, under optimal environmental conditions, can reduce soybean yield by as much as 80 percent. It is a potentially damaging disease because it's severity can double every 2 to 9 days depending on environmental conditions. It is expected to quickly become endemic to coastal regions in southern Texas and parts of Florida (Pivonia and Yang, 2004) and could cost United States soybean producers $240 million to $2.0 billion annually (Livingston, et al., 2004). A less aggressive species of soybean rust, *Phakopsora meibomiae,* also occurs throughout the world but is not considered yield limiting to soybean in the United States.

After Asian soybean rust was first recorded in Japan in 1902, the pathogen moved through Asia, Australia, and Africa before it was discovered in South America in 2000. Asian Soybean Rust has been moving northward through South America now occurs as far north as seven degrees South latitude in Brazil.

The overwintering source(s) of primary inoculum for soybean rust in the United States is not known although at least 20 host species (including kudzu) are known to exist in the southern United States. Current research suggests the pathogen will overwinter in certain areas surrounding the Gulf of Mexico and in the Caribbean. Research also suggests that soybean rust will not overwinter in Virginia or other Mid-Atlantic soybean growing states. Rust spores will most likely be transported into Virginia via wind or other mechanisms. Rust spores must be introduced into Virginia, be deposited on a suitable host, and be exposed to sufficient free moisture and moderate temperatures to initiate germination before yield loss will occur.

The most severe epidemics of Asian soybean rust occur when soybean leaves are infected early in the growing season, however leaves are susceptible at all stages of plant growth. Soybean rust pustules have been recorded on soybean as early as the V1 stage of development and can reproduce on cotyledons, stems and pods.

Epidemics of soybean rust are greatly influenced by environmental conditions. Weather conditions during spore dispersal, deposition, and germination greatly influence the success rate of lesion development as well as the time it takes for disease severity to double (i.e., from 2 to 4% severity or 20% to 40% severity). Germination of urediniospores and subsequent host penetration and

lesion development require a minimum of 6 to 7 hours of continual wetness with an optimum infection rate occurring if dew periods are ≥ 12 hours in duration with temperatures between 65 to 80° F (18 to 26.5^{o} C) during the wetness period (Melching et al., 1989). Spores can remain viable in the absence of moisture for durations of no more than 8 days (Kitani and Inoue, 1960; Melching et al., 1989). However, Paltil et al., 1977 reported that soybean rust spores could survive 50 days in the shade. Spore viability is negatively influenced by ultraviolet light. Exposure to sunlight reduces viability of spores compared to spores exposed to cloudy conditions (Melching et al., 1989).

Additional Asian soybean rust identification information is listed in Appendix 1.

Information on the Section 18, Emergency Quarantine Exemption for use of fungicides to prevent and treat Asian soybean rust can be found in Appendix 2.

Confirmation Process

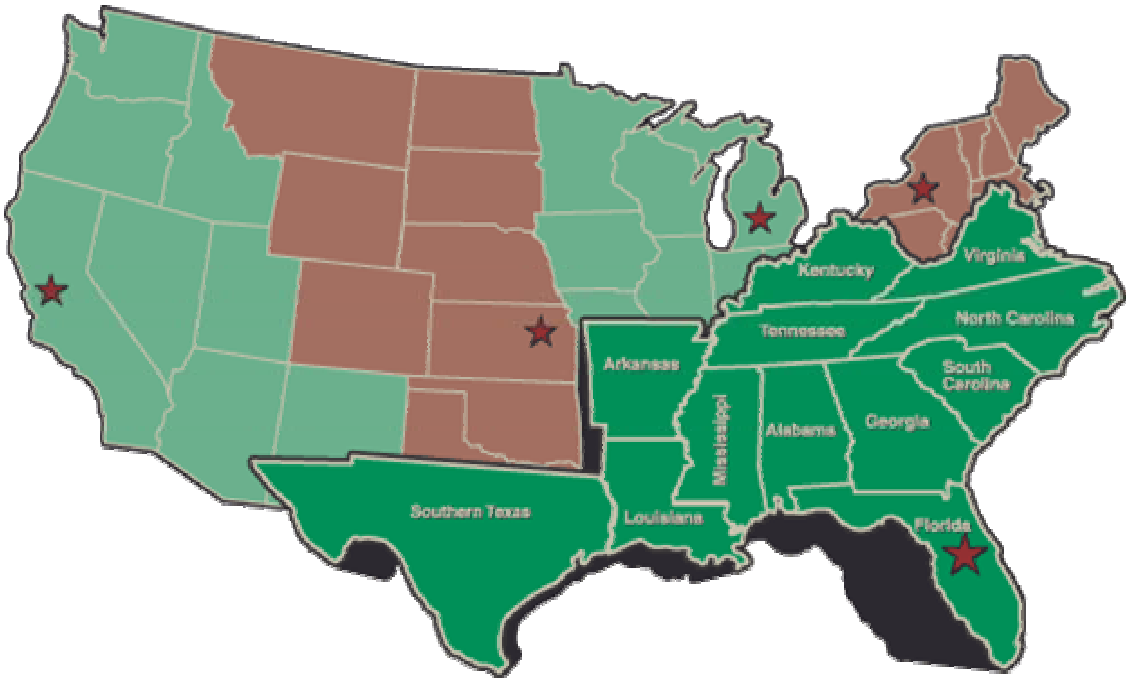
USDA-APHIS-PPQ has regulatory authority over threatening, nonnative organisms. Because rust has been identified as a Select Agent (42 CFR 73) by the United States Department of Homeland Security, particular attention has been focused on early detection and response activities.

The communication script, to be implemented when the Virginia Tech Plant Disease Clinic believes that a positive identification of rust has been made in Virginia, can be found in Appendix 3.

National Plant Disease Network

The mission of the National Plant Diagnostic Network is to enhance national agricultural security by quickly detecting introduced pests and pathogens. This is achieved by creating a functional nationwide network of public agricultural institutions with a cohesive, distributed system to quickly detect deliberately introduced, high consequence, biological pests and pathogens into our agricultural and natural ecosystems by providing means for quick and accurate identifications and establishing protocols for immediate reporting to appropriate responders and decision makers.

The network provides training and continuing education opportunities to diagnosticians to maintain highly skilled state lab personnel. It allows Land Grant University diagnosticians and faculty, State Regulatory personnel, and first detectors to efficiently communicate information, images, and methods of detection throughout the system in a timely manner. Lead universities have been selected and designated as Regional Centers to represent 5 regions across the country. Virginia Tech is a member of the Southern Plant Diagnostic Network, with the lead lab located at University of Florida.



NOTE: The presence of soybean rust in Virginia will not be considered confirmed by state or federal officials until both the expert lab in Florida and the USDA lab in Beltsville, Maryland, positively identify the sample as Asian Soybean Rust (*Phakopsora pachyrhizi)*. **The Section 18 for fungicides will not be implemented until confirmation in the continental United States.**

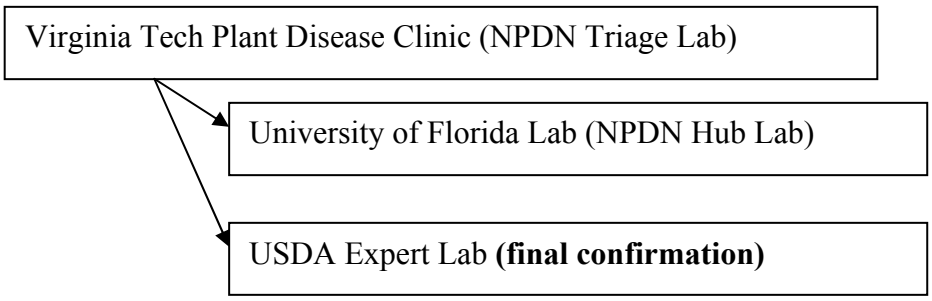


Figure 1. *If Virginia Tech believes the sample is likely to be rust, they responsible for submitting the sample to the NPDN lab in Florida and USDA*

In March 2004, Virginia participated in a 'soybean rust scenario exercise' – a trial run of a communication plan including Virginia's designated NPDN lab at Virginia Tech. The focus of the scenario exercise was to conduct a trial run of a communication plan, including the NPDN expert lab in Florida, USDA lab in Beltsville, Maryland, and state of Virginia and federal plant health regulatory authorities. The communication plan covers all steps of the process from the time that a

suspect sample is received by the Virginia Tech lab, until leading federal officials confirm it. The communication script used in the scenario will be implemented when Virginia Tech determines that a suspect sample must be sent to the expert lab for final identification.

Development of an Virginia First Detector Alliance

The purpose of this alliance would be to enable a cost-effective, widespread network of trained observers to monitor (survey) soybean fields, in every county, for the presence of soybean rust. It would maximize the states ability to quickly detect the pathogen and initiate a response and recovery plan.

Members of the alliance will be trained through the First Detector training program. Ideal members would be agronomists, crop consultants, and/or crop advisors from Virginia Cooperative Extension, Virginia Crop Production Association, major seed and chemical companies, and major cooperatives. We would strongly recommend that first detectors hold the CCA, CPCC, or CPAg certification. Members will be chosen based on test scores from the First Detector Training program and from past, positive, experiences with Virginia Cooperative Extension.

Establish an effective communication system. Members of the network should be in constant contact with Virginia Tech Extension Specialists via cellular telephone and email. First Detectors could participate in daily/weekly conference calls to discuss rust issues and record, including GPS coordinates, confirmed locations of soybean rust. This information could be used to track the movement and severity of the disease throughout the state. This two-way communication system would be critical in the early stages of the epidemic.

Commonly Used Terms

First Detectors –First detectors are composed of Certified Crop Advisors (CCA), Certified Professional Agronomists (CPAg), Extension Specialists and Agents, crop consultants, and other agronomists.

Triage Personnel – Triage Personnel are VDACS and Virginia Tech Extension Plant Pathologists who will act as the first screen of potential rust samples. They have advanced training in plant disease diagnostics.

Suspect Sample – A plant sample that is awaiting positive identification.

Confirmation – A positive identification of a plant sample as Asian soybean rust (*Phakopsora pachyrhizi)*.

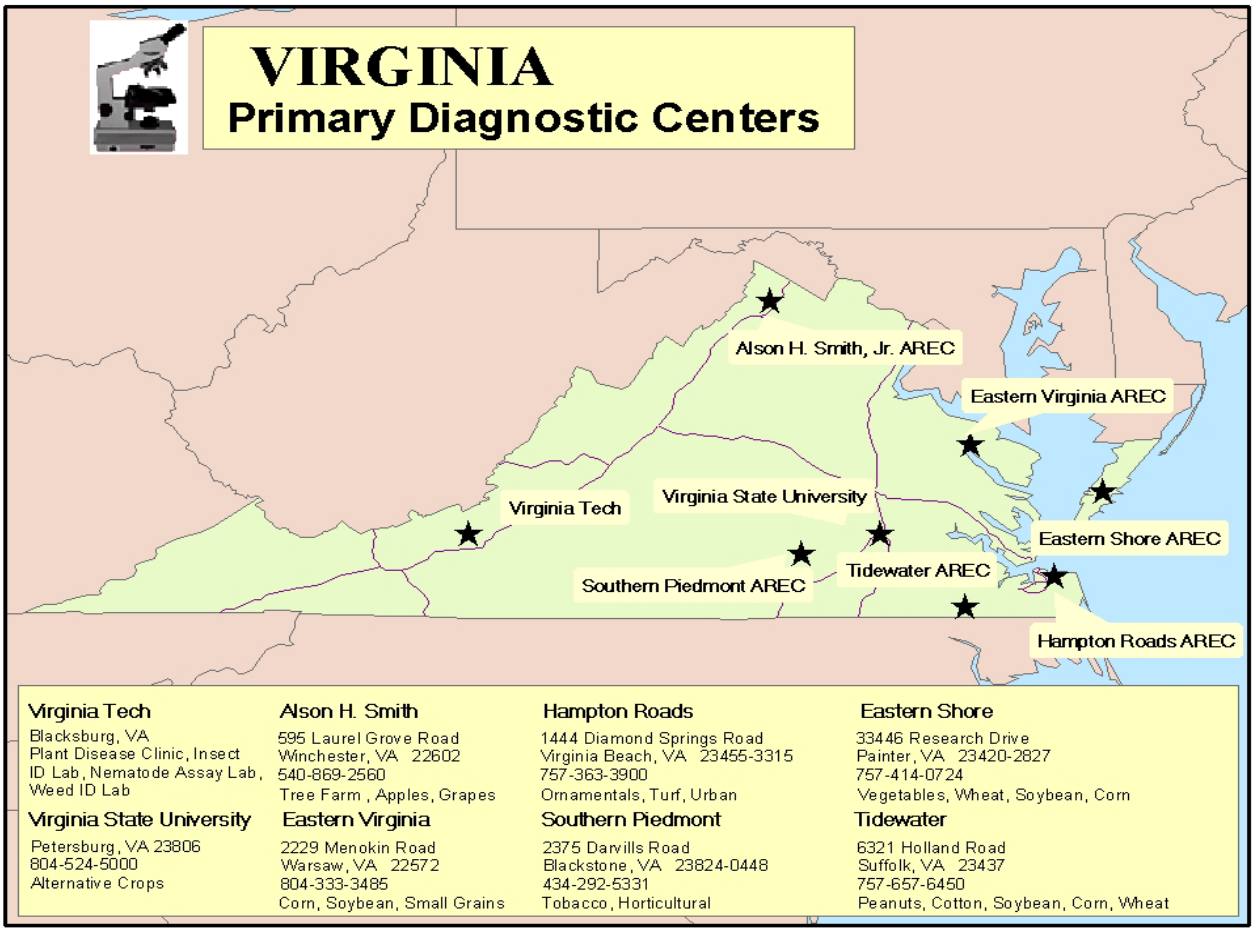
Training of First Detectors

Certified Crop Advisors (CCA), Certified Professional Agronomists (CPAg), Extension Specialists and Agents, crop consultants, and other agronomists will be trained as First Detectors of Asian soybean rust, in September 2004. A detailed agenda of the training program can be found in Appendix 4. First detectors comprise the eyes and ears of the monitoring programs because they monitor the growth and development of Virginia's soybean crop on a regular basis. First Detectors will be trained to accurately identify all foliar soybean diseases that produce symptoms that may be confused with Asian soybean rust. Training will be provided by Virginia Tech faculty and the VDACS.

Triage Personnel

Triage can be defined as the sorting and allocation of treatment according to a system of priorities designed to maximize success. In plant health management, triage personnel have advanced training in diagnosing symptom from a pathogen with similar characteristics as Asian soybean rust. Triage Personnel will act as the first screen of potential rust samples to keep the Virginia Tech Plant Disease Clinic from being overloaded with avoidable samples. Six primary diagnostic

centers in Virginia can serve in this capacity. These diagnostic centers either have a resident plant pathologist or have the ability to quickly and effectively communicate with a trained plant pathologist. The centers contain stereoscopes equipped with digital cameras, therefore can transfer visual images to triage personnel via electronic communication. Contact information for triage personnel can be found in Appendix 5.



Virginia Soybean Rust Monitoring Program

In addition to the first detector alliance, Virginia Tech, via funding from the Virginia Soybean Board, has a monitoring program in place. Over a period of two weeks, selected fields will be scouted for soybean rust every two weeks. The locations of these fields are shown in Figure 2 and represent the major soybean growing regions of the state. Most fields were planted in May and will be flowering in July. The scout will check lower leaves for signs and symptoms of soybean rust in 5 to 10 locations within the field. If signs or symptoms are found, the scout will several leaves in a zip lock bag, place in a cooler, and submit the sample to the Tidewater AREC primary diagnostic center. The scout will also take a digital picture of the leaves in the field and after returning to the Tidewater AREC. These photos can be used in the future to build a library of photos that will assist in identifying soybean rust or look-alike diseases or other injury. The scout will communicate daily and report any findings with Tidewater AREC Extension Specialists.

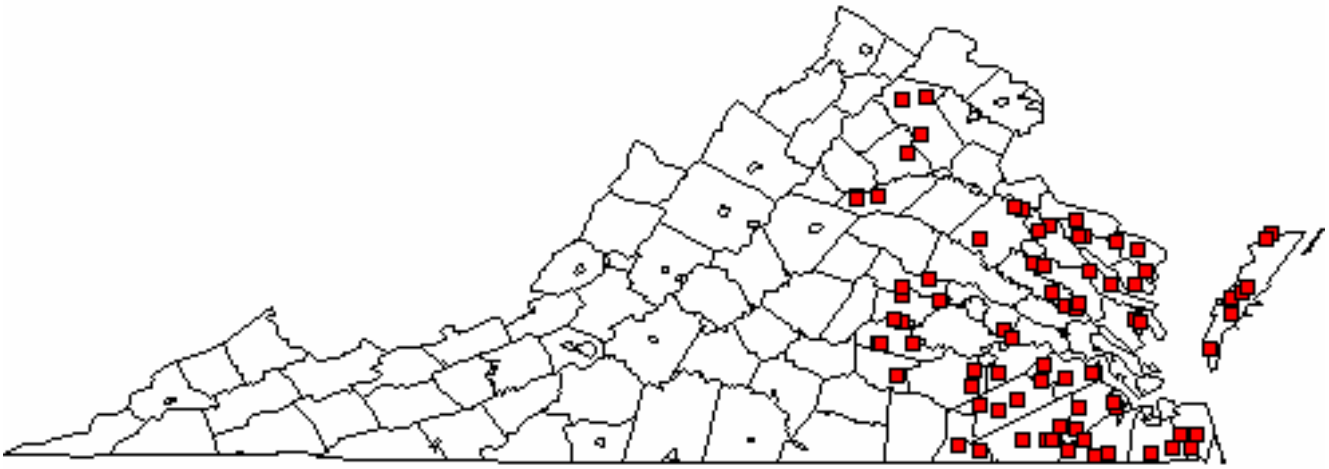


Figure 2. *Locations of fields in Virginia's soybean rust monitoring program.*

Asian soybean rust will generally not express itself until the soybean plant enters reproductive stages. Therefore, soybean rust would not generally be detected until Virginia's crop begins to flower and produce pods in late-July. Therefore, to detect an early invasion, early-maturing soybean varieties (maturity group III) were planted in April in small 1- to 5-acre plots near many of the monitoring locations. These "trap plots" will flower in June, produce pods and seed in July, and express soybean rust symptoms about 1 to 1 ½ months earlier than most of Virginia's crop. These plots will be monitored as described above.

Submission of Plant Samples

To keep from overburdening the Virginia Tech Plant Disease Clinic with avoidable suspect samples, **First Detectors, producers, agronomists, etc., must contact Triage Personnel before submitting samples to the Virginia Primary Diagnostic Centers**. Triage personnel are trained to recognize symptoms from pathogens with similar characteristics as rust. Plant sampling instructions and a Plant Sample Submission Form are shown in Appendix 6. Figure 3 depicts the flow of the identification and confirmation process.

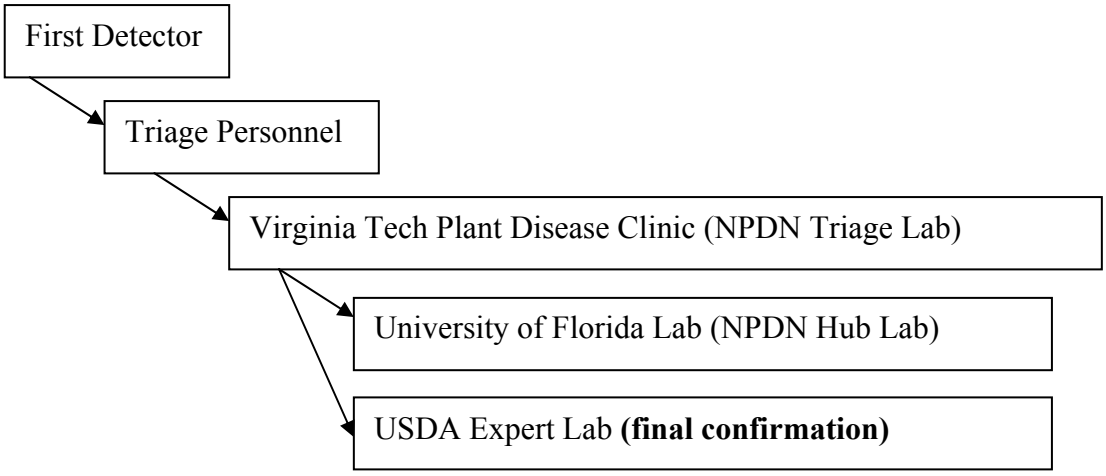


Figure 3. *Identification and confirmation process: First Detectors must contact Triage Personnel before a suspect rust sample may be submitted to the Virginia Tech lab for diagnosis. If Virginia Tech believes the sample is likely to be rust, Virginia Tech is responsible for submitting the sample to the NPDN lab in Florida and USDA expert lab in Beltsville, MD.*

Communication Plan

Pre-confirmation

The purpose of a pre-confirmation communication plan is to 1) ensure that all stakeholders are prepared for an epidemic of soybean rust; 2) identify and commit resources to carryout an effective post-confirmation communication program; 3) increase grower awareness of actions of stakeholders to reduce the impact of a rust epidemic; and 4) assemble relevant information on identification and management of soybean rust that, when transferred, will enable the producer to minimize the impact of soybean rust.

Action items in this category can be initiated immediately and should continue until soybean rust is confirmed in the United States. Items to be produced may include:

- √ Talking points for Virginia Tech administration including College of Agriculture and Life Science Dean Sharron Quisenberry, Commissioner of Agriculture J. Carlton Courter, III, and leaders of the Virginia Farm Bureau, Virginia Soybean Association and Virginia Soybean Board. Audience is the general public.
- √ Press releases – One to be released in July 2004 to highlight the university/stakeholder collaboration. Other dates to be determined by communications group. Audience is the general public and soybean growers.
- √ Develop a list of Frequently Asked Questions and Answers Appendix 7
- √ Develop a series of fact sheets to be distributed to media.
    - Include the National Pest Alert system for Soybean Rust

- History of Asian soybean rust as it progressed from Asia through South America and into the United States
- Highlight ongoing research.
- Soybean producer action recommendations – expected yield loss if left untreated
- List of approved fungicides and application rates / timing of application

√ Develop www.ext.vt.edu/soybeanrust to be a centralized source of information on soybean rust. *Web site developed by Virginia Cooperative Extension.*

- Include list of Frequently Asked Questions & Answers
- Include rust background material
- Include confirmed location / severity of rust
- Include farmer action recommendations
- Include list of approved fungicides and application recommendations (to be provided by chemical companies)
- Include links to credible Web sites for additional information such as www.planthealth.info and www.aphis.usda.gov/ppq/rust

√ Develop a soybean rust brochure to help producers identify "look-alike" diseases and instructions on how to submit suspect samples for identification. (In progress)

√ Consider the development of a "Training Video" on how to scout and ID soybean rust.

√ Develop a plan to handle unconfirmed and unverified reports of soybean rust in the United States and Virginia.

√ Develop a primary and secondary key contact list for distribution to the media with names and telephone numbers of predetermined spokespersons (Appendix 8).

√ Prepare resources that can be used and disseminated at high-traffic functions such as the Virginia Ag Expo, the Virginia State Fair, other county fairs, field days, and festivals.

√ Develop a contact plan for County Extension offices. Provide reference materials on approved university spokespersons for soybean rust and where to go for information. We may want to develop contact plans for various scenarios or "alert" levels.

√ Consider sending a supply of soybean rust background/management fact sheets and information to all Farm Service Agencies, County Extension offices, local agricultural dealers, and country buyers (local elevators) for dissemination upon confirmation of rust in the United States.

Post-confirmation

The purpose of the post-confirmation communication plan is to minimize the impact of a rust epidemic. This will be accomplished by 1) the rapid distribution of print material containing information needed to manage the disease and 2) effective utilization of radio, TV and print media to educate the soybean producer on the need to scout and treat for soybean rust.

Two post-confirmation communications plans could be developed for when 1) rust is first confirmed in the United States and 2) soybean rust is first discovered in Virginia.

- √ Develop and distribute list of key persons whom should be informed prior to release to media (Appendix 7)
- √ Prewritten press releases – develop two to three with fill-in-the-blanks for dates and location of confirmation, etc. that can be quickly released to the media. They should include key messages, such as:
  - Virginia Tech, VDACS, USDA, industry and stakeholders have been preparing for the arrival since 2002.
  - This is a serious threat to our soybean crops, but thanks to our preparation in recent years, there are a number of treatment options available to soybean producers.
  - VDACS, USDA and Virginia Tech are looking into how the disease reached Virginia, but we are not aware of any evidence it was done intentionally.
  - Explain how the USDA-ARS, academia, and the soybean checkoff have focused on finding solutions to yield loss from soybean rust.
  - Direct interested parties to key Web sites for information:
    - 1) www.ext.vt.edu/soybeanrust
    - 2) http://www.apsnet.org
    - 3) http://www.aphis.usda.gov/ppq/ep/soybean_rust/
    - 4) http://cipm.ncsu.edu/ent/SSDW/soyatlas.htm
    - 5) http://www.soybeanrustinfo.com
    - 6) http://www.stopsoybeanrust.com/
    - *Other web sites?*
- √ Propose to the Virginia Pilot, the Richmond Times, Farm Bureau News, Virginia-Carolina Farmer, DelMarVa Farmer, and other newspapers and magazines, that they print a large article on management of soybean rust.
- √ Initiate daily or weekly conference calls for members of the Virginia First Detector Alliance.
- √ Initiate outreach program at high-traffic functions such as the Virginia Ag Expo, the Virginia State Fair, other county fairs, field days, and festivals to increase awareness.
- √ Enable Farm Service Agency, County Extension offices, local cooperatives, dealers, and country buyers (local elevators) to disseminate print material.
- √ Develop a network to keep producers and media informed of the progression and severity of rust once it enters the US.
  - www.ext.vt.edu/soybeanrust
  - Virginia Soybean Update and other newsletters
  - Press releases
  - Daily? Weekly interviews with radio, print media
  - Outreach through grower meetings

Activation of the Soybean Rust Action Plan

Confirmation outside Virginia

Notification and Mobilization

Execute post-confirmation communication plan

The first hour

√ Notify Virginia Soybean Rust Task Force members (Appendix 7)

The first day

√ Organize & conduct press briefing to inform Virginia producers of preparations that have been made in anticipation of arrival of rust, including approved Section 18 fungicides … Determine location & time for press briefing

√ If United States Secretary of Agriculture makes the announcement, then Virginia Commissioner of Agriculture should comment about Virginia's level of preparedness. If USDA make announcement, then Virginia Tech should make public comment about our states level of preparedness.

√ Print off fact sheets for dissemination at briefing.

√ Send out soybean rust fact sheets/background information and farmer action recommendations to media via email.

Needs for Mobilization

- A "workhorse" to ensure completion of the communication plan
- Well-versed Doctoral or M.S. student who can field phone calls from growers and direct media to appropriate spokespersons.

Activation

Activate the First Detector Alliance.

Activate the "black section" of the www.ext.vt.edu/soybeanrust Web site.

Assemble available rust working group members to assess effectiveness of communication efforts and determine additional needs.

The SPRO with VDACS has the authority to restrict or prohibit the importation of live rust spores into Virginia. An approved PPQ Form 526, *Application For Permit To Move Live Plant Pests Or Noxious Weeds*, is required prior to any movement of live rust spores. Unless warranted, the movement of live rust spores for research purposes will not be approved until after rust is confirmed in Virginia?

Confirmation within Virginia

Notification and Mobilization

Execute post-confirmation communication plan

The first hour

- √ Notify Virginia Soybean Rust Task Force members (Appendix 7)
- √ If Virginia is first U.S. detection, secure the field containing soybean rust and evaluate Homeland Security implications (VDACS & USDA).
- √ Announce time and location for press briefing

The first day

- √ Reserve time for the Virginia Rust Task Force conference call.
- √ Contact Agrinet Radio, which covers Eastern PA, Delmarva VA, and Eastern NC, for rapid dissemination of news concerning confirmation of soybean rust.
- √ Send out public statement from VIRGINIA TECH Extension.
- √ Print off fact sheets/background information for dissemination at briefing
  - Be sure information is available on various Web sites as well
- √ Send out soybean rust fact sheets/background information and farmer action recommendations to media via email
- √ Conduct press briefing with multiple organizations represented.
- √ Announce time for next press briefing as appropriate

Activation

Assemble available Virginia Rust Task Force members to assess effectiveness of communications efforts and determine additional tasks/needs.

Activate Virginia First Detector Alliance

Contact Agrinet Radio to inform soybean producers on what to look for, what to do, and where to go for information.

Continue daily communication between State authorities, Virginia Tech, and stakeholders

Initiate daily conference calls for the Virginia First Detector Alliance.

Ensure daily communication among Virginia First Detector Alliance members for the first two weeks of the epidemic. A high-tech information gathering system using satellites and a mapping system could be implemented.

Develop a mechanism or plan monitor (survey) and keep producers and media informed of progression /severity of rust once it enters Virginia.

- Daily/weekly updates with radio, print media
- Virginia Soybean Update Newsletter
- Press releases
- www.ext.vt.edu/soybeanrust and other websites.

Research Priorities

These are possible research projects only; a qualified research team, comprised of national experts, should/will determine ACTUAL RESEARCH priorities.

1. Develop an accurate early-detection tool to be used in the field by soybean producers and crop advisors.
2. Conduct proof-of-performance trials in Virginia. Current fungicide efficacy trials for soybean rust are being conducted outside the United States. Researchers at Virginia Tech should conduct fungicide trials under Virginia growing conditions to: 1) verify performance at recommended and possibly alternate use rates; 2) verify performance at each recommended time of application for each labeled fungicide/tank mix; and 3) determine compatibility and performance with commonly used insecticides used for corn earworm or other insects.
3. Develop an accurate method to predict and monitor migration of rust spores from overwintering sites into key soybean producing areas.
4. Population dynamics – Monitor the population of *Phakopsora pachyrhizi* in the U.S. for genetic shifts. Monitor performance against labeled fungicides. Compare the population in the U.S. to those in Brazil, China, Taiwan, etc.
5. Develop systems that allow soybeans to mature earlier and avoid late-season invasion of soybean rust.
    a. Virginia's double-crop soybeans are at the most risk. Unless double-crop soybeans remain profitable, the future of wheat and barley production in the state is also at risk. Therefore, there is a need to develop a system in which soybean can be planted into tillering or jointing wheat (relay cropping system).
    b. Re-evaluate Early Soybean Production Systems that will mature earlier in the year.
6. Other…

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APPENDIX

One

Identification of Soybean Rust

(The following material was taken from the Minnesota Soybean Rust Response Plan and from Soybean Disease Information Note 8, from the Clemson, Georgia, North Carolina, and Virginia, Cooperative Extension.)

Accurate and timely identification is the key to determining whether a response will be attempted and, if so, the extent, direction, and magnitude of that response. It will also help determine program changes and failures.

General Information

An important new disease threat to soybean is currently the cause of much concern in the agricultural community. Asiatic soybean rust, caused by *Phakospora pachyrizi*, has emerged as a major constraint to soybean production in South America since 2001. Another species of rust *Phakospora meibomiae* has been endemic to portions of South America for many years but is considered less of a threat because it is not as aggressive as the Asiatic soybean rust. During the 2003-2004 growing season in Brazil, Asiatic rust was severe in many areas and required sprays of fungicides in order to control this disease (Fig. 1). Many industry leaders and some scientists predict that its introduction to North America is eminent and that it will impact US soybean production. Asiatic soybean rust is present in Hawaii, but has not yet been reported in the Continental US. Some plant pathologists, however, suspect that it would be a minor problem if and when it does arrive in the US. Predictive models suggest that conditions in Georgia, South Carolina, Virginia, and North Carolina are favorable for development of an epidemic of soybean rust. The soybean rust pathogen is primarily tropical in distribution and would be able to survive over winter in only the most southern portions of the US (Southern Florida and Texas). Alternate hosts for Asiatic soybean rust in the US include kudzu, winter vetch, and lupines. Should this disease be introduced to the US an emergency registration of additional fungicides for use on soybean will take effect for three years.

Symptoms

Symptoms of soybean rust appear identically regardless if they are caused by *Phakopsora pachyrhizi* or *Phakopsora meibomiae*. Infection begins on the lower first leaves of plants and appears as chlorotic or mosaic-like areas. Host plants infected with soybean rust first exhibit small superficial lesions that gradually increase in size and turn from gray to tan or brown. Lesions will contain one to three rust pustules which are raised on the leaf surface and may eventually reach 2 to 3 square millimeters. (Figs. 2-5). The lesions may have an angular appearance and be limited by leaf veins. Rust pustules may appear on cotyledons, leaves, petioles, stems, or pods, but are most likely to be observed as raised pustules on the under side of the leaf. As the plant matures and sets pods, infection progresses rapidly under the right environmental conditions (i.e., moisture, high humidity and heat) to cause high rates of infection in the middle and upper leaves of the plant. Clouds of spores have been observed within and

above canopies of highly infected plant stands. The pustules are quite small (about the size of a pin head) and can be confused with another disease, bacterial pustule. Bacterial pustule, however, is rare in commercial soybean varieties, since most if not all are resistant to this disease. A 20X or greater hand lens may aid in seeing the raised nature of the pustule, but early the stages of disease are difficult to distinguish if no spores, conidia, or bacteria are evident. Also, placing leaves in a plastic bag with a moist paper towel for twenty four hours may cause the pustules to erupt, thus making identification easier. Each pustule contains hundreds of spores. Spores are elliptical to obovoid in shape, colorless to yellowish or yellowish brown and minutely and densely spiny (Fig 6.). Infected plants will senesce early and have smaller seed with reduced yield.

Plants show two different lesion reactions to infection by soybean rust. Tan lesions consist of small uredinia surrounded by slightly discolored necrotic areas on leaf surfaces. The other type of lesion that occurs with soybean rust infection is the reddish-brown lesion. These lesions have larger areas of necrosis that are reddish brown surrounding a limited number of uredinia. A few urediniospores are usually visible on the surface. These leaf lesions vary from small specks to large irregular brown areas that form when small lesions coalesce. A hand lens or dissecting microscope are usually used to distinguish these disease symptoms from ASBR, but early the stages of disease are difficult to distinguish if no spores, conidia, or bacteria are evident.

Disease Cycle and Epidemiology

Windblown spores infect susceptible tissue at temperatures of 45 to 83 degrees. Leaves must be wet for infection to occur. Pustules will develop within a week to ten days after infection, and spores are produced after about three weeks. The spores are the only survival structures for this fungus and they will not survive freezing weather. The role other hosts (kudzu, winter vetch, lima beans, dry beans, and lupines) might play is not known, but fields with kudzu along borders might be a good place to start scouting. Soybean rust may be able to survive in southern Florida and Texas, but the soybean acreage in these states is limited at this time. Several species of common bean are also hosts for this fungus, but fungicide sprays to control other diseases on these vegetable crops may limit rust development. For states on the Atlantic Coast, windblown spores will have to move northward from southern Florida. A second possibility is for spores to come from the Mississippi Valley. In 2003, Soybean acreage in Florida was less than 10,000 and only about 150,000 in Georgia. Thus the potential for windblown inoculum coming from these sources is not terribly high. For rust to be damaging first infections will probably have to occur before the R3 stage of soybean development.

Management

In areas with a high likelihood of infection it is suggested that growers consider removing alternative host material, especially kudzu, from field borders. The removal of this material will reduce the amount of hosts available, thereby reducing the amount of available host material to initiate an infection while decreasing the availability of sites for inoculum buildup.

The best long-term strategy for minimizing the effects of soybean rust in the United States is in the development of resistant/tolerant varieties. There are thousands of plant lines of soybean in germplasm repositories and screening for soybean resistance has been on-going for several years in other countries and the United States in the containment facilities at the ARS Foreign Disease-Weed Science Research Unit in Ft. Detrick, Maryland. However, the availability of cultivars

with good resistance and other characters desired in soybean for commercial production is still five to seven years away.

Immediate management of soybean rust will be with fungicides. Currently, the only fungicides labeled for soybean that are effective in managing soybean rust are chlorothalonil (various brands) and azoxystrobin (Quadris). Although Topsin M is also labeled for soybean, it is not effective against rusts. If soybean rust is identified in the Continental US an emergency registration of eight additional fungicides will go into effect for three years (Table 1). In general the recommendation will be to make one application at the R3 stage of development and a second one 10-14 days later. Late season sprays (after R5 to R6) have not been effective in South America unless they follow an earlier spray. Because soybean rust may develop resistance to the triazole and strobilurin class of fungicides, it may be best to rotate the use of materials. Preliminary reports indicate that the triazole type fungicides have more curative activity than the strobilurin class fungicides, the first spray should be a triazole fungicide and the second spray should be made with a strobilurin. If a third spray is required chlorothalonil might be the best option since it may control some other late season diseases that the other materials do not.

Table A1. Fungicides for management of soybean rust.

Brand Name	Common Name	Fungicide Class	Currently labeled on soybean	Will be labeled for soybean rust
Bravo	Chorothalonil		yes	
Quadris	Azoxystrobin	Strobilurin	yes	
Headline	Pyraclostrobin	Strobilurin	no	yes
Tilt, PropiMax, Bumper	Propiconazole	Triazole	no	yes
Folicur	Tebuconazole	Triazole	no	yes
Laredo	Myclobutanil	Triazole	no	yes
Domark	tetraconazole	Triazole	no	yes
Stratego	Propiconazole + trifloxystrobin	Triazole Strobilurin	no	yes
Pristine	Pyraclostrobin + Boscalid	Strobilurin Anilide	no	yes

Figure A1.1. Soybean infected with soybean rust in Parana State BS near Londrina, from left to right unsprayed, sprayed once with a fungicide and sprayed twice with a fungicide (Photo by Steve Koenning).

Figure A1.2. Soybean Rust on soybean leaf (Photo by Steve Koenning).

Figure A1.3. Soybean rust on a mature and a senescing leaf (Photo by Steve Koenning).

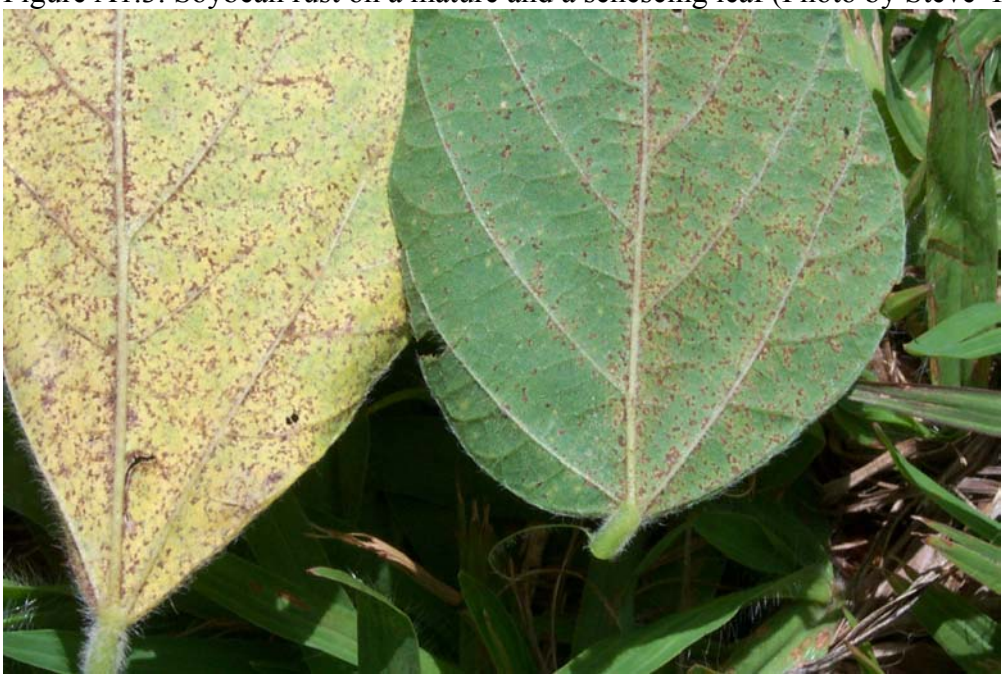

Figure A1.4. Lesions containing several rust pustules of soybean rust (from Compendium of Soybean Diseases, APS Press, St. Paul, MN).

Figure A1.5. Enlarged view of leaf lesion of soybean rust containing pustules. Note the angular appearance of the lesion (Photo from Compendium of Soybean Diseases APS Press, St. Paul, MN).

Figure A1.6. Spores of soybean rust (Photo from Compendium of Soybean Diseases APS Press, St. Paul, MN).

APPENDIX

TWO

Fungicides Submitted for Approval Under the Section 18, Emergency Quarantine Exemption

NOTE. An application for Section 18 approval has been submitted by IDALS on or about November 10, 2003. The Section 18 application package has not been approved, as of 4/22/04.

- The application requested up to two applications of an approved fungicide on eighty percent of the acres planted to soybean in Virginia.
- When approved, the Section 18 Emergency Quarantine Exemption to apply fungicides as a protective or curative treatment will **NOT** be enacted until Asian soybean rust (*Phakopsora pachyrhizi*) is confirmed in the continental United States.

Products are listed in order of greatest potential for availability and preference for use.

Common Chemical Name (Active Ingredient): **propiconazole**

Trade Names(s)And EPA Reg. No.: Tilt®, EPA Reg. Number 100-617
Formulation: 3.6EC
% Active Ingredient: 41.8% (3.6 lb/gal)
Manufacturer: Syngenta Crop Protection, Inc.; Greensboro, NC 27409

Common Chemical Name (Active Ingredient): **propiconazole**

Trade Names(s)And EPA Reg. No.: PropiMax™ EC, EPA Reg. Number 62719-346
Formulation: 3.6EC
% Active Ingredient: 41.8% (3.6 lb/gal)
Manufacturer: Dow Agrosciences, LLC; Indianapolis, IN 46268

Common Chemical Name (Active Ingredient): **propiconazole**

Trade Names(s)And EPA Reg. No.: Bumper®, EPA Reg. Number 66222-42
Formulation: 41.8EC
% Active Ingredient: 41.8% ai by weight (3.6 lb/gal)
Manufacturer: Makhteshim-Agan; New York, NY 10176

Common Chemical Name (Active Ingredient): **tebuconazole**

Trade Names(s)And EPA Reg. No.: Folicur®, EPA Reg. Number 3125-394
Formulation: 3.6F
% Active Ingredient: 38.7% (3.6 lb/gal)
Manufacturer: Bayer Corporation; Kansas City, MO 64120-0013

Common Chemical Name (Active Ingredient): **myclobutanil**

Trade Names(s)And EPA Reg. No.: Laredo™ EC, EPA Reg. Number 62719-412
Formulation: 25EC
% Active Ingredient: 25% (2 lb/gal)
Manufacturer: Dow AgroSciences LLC; Indianapolis, IN 46268

Common Chemical Name (Active Ingredient): **myclobutanil**

Trade Names(s)And EPA Reg. No.: Laredo™ EW, EPA Reg. Number 62719-493
Formulation: 25EW
% Active Ingredient: 25% (2 lb/gal)
Manufacturer: Dow AgroSciences LLC; Indianapolis, IN 46268

Common Chemical Name (Active Ingredient): **propiconazole + trifloxystrobin**

Trade Names(s)And EPA Reg. No.: Stratego®, EPA Reg. Number 264-779
Formulation: 2.08F
% Active Ingredient: 11.4% propiconazole (1.04 lb/gal), 11.4% trifloxystrobin (1.04 lb/gal)
Manufacturer: Bayer Corporation; Kansas City, MO 64120-0013

Common Chemical Name (Active Ingredient): **tetraconazole**

Trade Names(s)And EPA Reg. No.: Domark™, EPA File Symbol 60063-RE
Formulation: 125SL
% Active Ingredient: 11.6% (125g/l ai – 1 lb ai/gal)
Manufacturer: Sipcam Agro USA, Inc.; Roswell, GA 30076

Common Chemical Name (Active Ingredient): **pyraclostrobin + boscalid**

Trade Names(s)And EPA Reg. No.: Pristine®, EPA Reg. Number 7969-199
Formulation: 38% WDG
% Active Ingredient: 25.2% boscalid, 12.8% pyraclostrobin (38% total ai)
Manufacturer: BASF Corporation; Research Triangle Park, NC, 27709

Common Chemical Name (Active Ingredient): **pyraclostrobin**

Trade Names(s)And EPA Reg. No.: Headline®, EPA Reg. Number 7969-186
Formulation: 2.09EC
% Active Ingredient: 23.6% (2.09 lb ai/gal)
Manufacturer: BASF Corporation; Research Triangle Park, NC, 27709

APPENDIX

THREE

Pre-Confirmation Communication Script

(Adapted from APHIS Pest of Concern Scenario)

Step 1 –Grower, Pest Advisor or other Sample Submitting Entity brings sample and submits diagnosis request to Virginia Cooperative Extension or VDACS.

Step 2a – Virginia Cooperative Extension or VDACS delivers sample to Virginia Primary Diagnostic Center. Triage personnel examines sample and determines whether or not it should be forwarded to the National Plant Diagnostic Network (NPDN) Triage Lab in Blacksburg.

Step 3a – Triage personnel delivers sample to National Plant Diagnostic Network Triage Lab in Blacksburg.

Step 3b - Triage Lab staff acknowledges receipt and enters the sample into the system assigning a unique lab ID number to the sample.

Step 3c - Triage Lab staff examines sample.

Step 3d - Triage Lab staff contacts Expert Lab and Animal Plant Health Inspection Service (APHIS) Confirming Diagnosis Designate to inform them that Triage Lab has received a suspect sample and is requesting confirming diagnosis. The APHIS Confirming Diagnosis Designate may be an APHIS National Diagnosis Service staff member or an NPDN expert lab diagnostician and is to be assigned by APHIS NDS staff.

Step 3e – Triage Lab staff, Expert Lab staff and APHIS Confirming Diagnosis Designate conducts live web-based distance diagnosis examination of sample and microscope mounts, if Triage Lab has this distance diagnosis capability. Or the diagnostician can take a digital image and email to the other two diagnosticians if web cam is not available.

Step 3f – Triage lab staff divides sample and sends to both the NPDN Expert Lab and the APHIS Confirming Diagnosis Designate for diagnosis, unless the Designate indicates to the Triage Lab to send only to one of the two entities. Sample is double bagged in "zip-lock" bags and sealed in a box with tape. Sample submission form is included in the box. Late afternoon and evening Fed Ex pickup locations can be found at www.fedex.com if needed.

Step 3g – Triage Lab informs Expert Lab and APHIS Diagnosis Designate of sample shipment time and delivery method, including tracking number and sample number.

Step 4a – Triage Lab staff contacts originating State APHIS State Plant Health Director (SPHD) staff to inform of suspect sample in the system.

Step 4b – APHIS SPHD prepares for response, but does not act until confirmation of diagnosis is received.

Step 4c - Triage Lab staff contacts originating State Plant Regulatory Official (SPRO) staff to inform of suspect sample in the system.

Step 4d - SPRO contacts counterparts in PA, DE, MD, NC, and SC of suspect sample.

Step 4e - State SPRO prepares for response in collaboration with APHIS SPHD, but does not act with response until confirmation of diagnosis is received.

Step 4f – Originating State SPRO and APHIS SPHD may choose to communicate with regulatory officers from neighboring states in planning and/ or activating response strategy.

Step 4g – Triage Lab staff contacts its own Campus Safety Officer to inform of suspect sample in the system.

Step 5a - Expert Lab Staff acknowledges sample receipt to Triage Lab.

Step 5b - Expert Lab staff examines sample.

Step 5c – Expert Lab staff contacts Local and/or Outside expert, for additional input, but does not disclose state of origin.

Step 5d - Local and/or Outside Expert examines sample.

Step 5e - Local and/or Outside Expert makes preliminary diagnosis in collaboration with Expert Lab staff.

Step 6a – Local and/or Outside Expert contacts Expert Lab Diagnostician with conclusions/results.

Step 6b – Expert Lab Diagnostician contacts NPDN Regional Director with local expert's preliminary conclusions/results.

Step 6c - Expert Lab staff contacts Expert Lab state's State SPRO and APHIS State SPHD to inform them that a suspect sample is housed in Expert Lab until shipment to APHIS Confirming Diagnostician or APHIS Designate or until it is destroyed following diagnosis. The state of origin is not disclosed to Expert Lab's state SPRO / SPHD.

Step 6d - Expert Lab staff contacts its own Campus Safety Officer to inform of suspect sample in the system. State of origin is not disclosed.

Step 7a – Regional NPDN Director from region of origin of the sample contacts other Regional NPDN Directors and NPDN Program Manager indicating that suspect sample is under diagnosis. State of origin is not disclosed except to Program Manager.

Step 7b – Regional NPDN Directors contact diagnosticians in their respective regions at NPDN labs in each state to inform them that a suspect sample is under diagnosis in an unknown location in the nation and to be alert for similar samples that may be appearing in other labs.

Step 7c - Regional NPDN Director in region of origin contacts other diagnostic labs in the region to say that a suspect sample is under diagnosis. State of origin is not disclosed.

Step 8 – Expert Lab in coordination with Local/Outside expert contacts APHIS Confirming Diagnosis Designate indicating that they are sending the sample to them including shipment date, method, tracking number and sample number.

Step 9 – Expert Lab ships to APHIS Confirming Diagnosis Designate, unless Designate specifies that shipment is not necessary.

Step 10a – APHIS Confirming Diagnosis Designate acknowledges receipt of sample to Triage Lab and /or Expert Lab. APHIS Confirming Diagnosis Designate also states approximate expected date and time of notification of results.

Step 10b - APHIS Confirming Diagnosis Designate examines sample and makes confirming diagnosis.

Step 10c – APHIS Confirming Diagnosis Designate contacts Bob Spaide or other appropriate APHIS staff with confirming diagnosis results.

Step 10d - Bob Spaide or other APHIS staff contacts State APHIS SPHD staff in state of origin with confirming diagnosis results

Step 10e – State APHIS SPHD staff contacts State SPRO staff in state of origin with confirming diagnosis results.

Step 10f – SPRO contacts Virginia Commissioner of Agriculture.

Step 10g – SPRO/Commissioner of Agriculture contacts Governor's office. Governor's office is asked to not comment on the situation, and instead refer questions to Virginia Tech or VDACS.

Step 10h – SPRO/ Commissioner of Agriculture contacts Virginia Office of Commonwealth Preparedness (VOCP). VOCP is asked to not comment on the situation, and instead refer questions to Virginia Tech.

Step 10i – Virginia Cooperative Extension will be tasked with releasing the news of the confirming diagnosis, and subsequent recommendations, to the public.

Step 10j – Shortly before media conference, SPRO contacts all SPROs in the USA through the National Plant Board..

Step 10l - State SPRO in state of origin submits record to state, regional and/or National Agricultural Pest Information Systems (NAPIS) databases.

Step 11a - APHIS Confirming Diagnosis Designate contacts Triage Lab Staff with confirming diagnosis results.

Step 11b – Triage Lab Diagnostician contacts expert lab staff with confirming diagnosis results.

Step 12a - Triage Lab staff submits record to NPDN databases at state, regional and NAPIS-NPDN databases

Step 12b - Triage Lab staff or APHIS contacts Sample Submitting Entity with results as approved and designated by APHIS.

Step 12c - Triage Lab staff contacts its own Campus Safety Officer w/ positive or negative result and assurance of sample destruction. State of origin is not disclosed.

Step 13 – Expert Lab staff contacts Regional NPDN Director with positive or negative result.

Step 14 – Regional NPDN Director contacts other NPDN Regional Directors w/ positive or negative result. State of origin is not disclosed.

Step 15 - Regional NPDN Director contacts National NPDN Program Leader w/ positive or negative results.

Step 16 – National Program Leader contacts Secretary of Agriculture w/ positive or negative result.

Step 17 – Expert Lab staff contacts SPRO and SPHD for its own state w/ positive or negative result and assurance of sample destruction. State of origin is not disclosed.

Step 18 - Expert Lab staff contacts its own Campus Safety Officer w/ positive or negative result and assurance of sample destruction. State of origin is not disclosed.

Step 19 – Regional NPDN Directors contact Regional NPDN Labs w/positive or negative result. State of origin is not disclosed.

APPENDIX

FOUR

First Detector Training Program for Soybean Rust in Virginia

TRAINING DATES AND LOCATIONS:

Sept. 1, 2004 Tidewater Agricultural Research & Extension Center (TAREC)
6321 Holland Road, Suffolk, VA 23437
(757) 657-6450

Sept. 2, 2004 Eastern Virginia Agricultural Research & Extension Center (EVAREC)
2229 Menokin Road
Warsaw, VA 22572
(804) 333-3485

TRAINING COORDINATOR: David Holshouser
Assoc. Professor & Extension Soybean Specialist
Virginia Tech - Tidewater AREC
6321 Holland Road
Suffolk, VA 23437
(757) 657-6450
dholshou@vt.edu

TEAM MEMBERS:

Erik Stromberg
Professor & Extension Plant Pathologist
Virginia Tech – PPWS
401 Price Hall
Blacksburg, VA 24061
(540) 231-7871
elstrom@vt.edu

Pat Phipps
Professor & Extension Plant Pathologist
Virginia Tech – Tidewater AREC
6321 Holland Road
Suffolk, VA 23437
(757) 657-6450
pmphipps@vt.edu

Ames Herbert
Professor & Extension Entomologist
Virginia Tech – Tidewater AREC
6321 Holland Road
Suffolk, VA 23437
(757) 657-6450
herbert@vt.edu

Frank Fulgham
Program Manager
VDACS – Office of Plant & Pest Services
Washington Bldg, Room 703
1100 Bank Street
Richmond, VA 23219
(804) 786-3515
ffulgham@vdacs.state.va.us

TARGET AUDIENCE:

Personnel to be trained would be those who are in regular contact with soybean growers and/or regularly visit soybean fields. These first detectors would include Virginia Cooperative

Extension (VCE) county agents; certified crop advisors and consultants; agronomists from seed/chemical companies, local dealers, and cooperatives; and field personnel from the Virginia Department of Agriculture and Consumer Services (VDACS), Natural Resource Conservation Service (NRCS), Soil and Water Conservation District (SWCD), and Farm Service Agency (FSA).

PURPOSE:

The purpose of this training program is to develop a "Virginia First Detector Alliance." This alliance would enable a cost-effective, widespread network of trained observers to monitor (survey) soybean fields, in every soybean-producing county, for the presence of soybean rust. It would maximize Virginia's ability to quickly detect the pathogen and initiate a response and recovery plan. Members of the alliance could be chosen based on test scores from the First Detector Training program and from past, positive, experiences with Virginia Cooperative Extension.

Once the training is completed, an effective communication system between the Virginia First Detector Alliance and Virginia Tech plant pathologists and other specialist will be established. Members of this network would be in constant contact with specialists via cellular telephone and email. First Detectors could participate in daily/weekly conference calls to discuss rust issues and record, including GPS coordinates, confirmed locations of soybean rust. This information would be used to track the movement and severity of the disease throughout the state. This communication system would be critical in the early stages of the epidemic.

TRAINING AGENDA:

8:30 – 9:00 **Registration** – Hand out packets

9:00 – 9:20 **Welcome and introductions –** David Holshouser

9:20 – 9.40 **History and economic impact of soybean rust** – David Holshouser

9:40- 10:00 **Biology and diagnosis of soybean rust** – Erik Stromberg & Pat Phipps

10:00 – 10:15 **Look-alike diseases -** Erik Stromberg & Pat Phipps

10:15 – 10:30 **Break**

10:15 – 10:30 **Can we confuse soybean rust symptoms with insect damage?** – Ames Herbert

10:30 – 10:45 **When and where will soybean rust likely appear** – David Holshouser

10:45 – 11:00 **Monitoring fields: scouting techniques, where to check, etc.** – Ames Herbert

11:00 – 11:30 **VDACS Response and Confirmation Process** – Frank Fulgham

11:30 – 12:00 **Applied Management Strategies** – Erik Stromberg and Pat Phipps

12:00 – 1:00 **Lunch**

1:00 – 4:00 **Hands-on training in local soybean fields: rust and rust-like signs and symptoms**

APPENDIX FIVE

Triage Personnel Contact Information

Dr. Erik Stromberg
Professor and Extension Plant Pathologist
Virginia Tech
Dept. of Plant Pathology, Physiology, & Weed Science
401 Price Hall
Blacksburg, VA 24061
O: (540) 231-7871
elstrom@vt.edu

Dr. Pat Phipps
Professor and Extension Plant Pathologist
Virginia Tech
Tidewater Agricultural Research & Extension Center
6321 Holland Road
Suffolk, VA 23437
O: (757) 657-6450 ext. 120
pmphipps@vt.edu

Ms. Mary Anne Hansen
Instructor
Virginia Tech
Dept. of Plant Pathology, Physiology, & Weed Science
106 Price Hall Plant Clinic
Blacksburg, VA 24061
O: (540) 231-6758
maryannh@vt.edu

APPENDIX

SIX

Plant Sample Collection Instructions

Once the triage person determines the sample should be submitted to the Virginia Tech Plant Disease Clinic, care must be taken to avoid contaminating other fields after sampling the suspicious plants. Inadvertent contamination on hands, clothing, vehicles and field equipment could result in unintentional spread of the soybean rust pathogen. A plant Disease Diagnostic Form is provided below and instructions on completing the form can be found at http://oak.ppws.vt.edu/~clinic/disease.html.

If soybean rust is suspected, the following actions should be taken:

1. Contact your local Extension Agent for collection, packaging and submission of samples to one on the labs listed below.
2. Work with your local Agent in completing the extension form to provide the lab with field location, disease distribution, symptoms, etc.
3. Samples should be submitted to the triage personnel listed below.

   A report of the results of diagnostic tests will be sent to the Extension Agent and person named on the extension form submitted with each sample.

Mary Ann Hansen
Plant Disease Clinic (0331)
106 Price Hall, Virginia Tech
Blacksburg, VA 24061
(email: maryannh@vt.edu)
(phone: 540-231-6758)

Dr. Erik Stromberg
Dept. Plant Path., Phys. & Weed Sci.
401 Price Hall, Virginia Tech
Blacksburg, VA 24061
(email: elstrom@vt.edu)
(phone: 540-231-7871)

Dr. Pat Phipps
Tidewater Agric. Res. & Ext. Ctr.
6321 Holland Rd.
Suffolk, VA 23437
(email: pmphipps@vt.edu)
(phone: 757-657-6450; ext. 120)

If the Virginia Tech lab suspects the sample to be Asian soybean rust, the Virginia Tech lab is responsible for:

1. Submitting the sample to the expert lab in Florida and the USDA-Beltsville lab.
2. Initiating the communication scrip (Appendix 4)

Virginia Cooperative Extension

Plant Disease Diagnostic Form

REPRINTED 2000 PUBLICATION 450-097

Submit specimens and this form to Plant Clinic, 106 Price Hall, Virginia Tech, Blacksburg, Virginia 24061-0331 Lab I.D. No. _____

SEE BACK PAGE FOR INSTRUCTIONS ON HOW TO COLLECT SPECIMENS AND COMPLETE THE NUMBERED SECTIONS OF THIS FORM.

1. Plant _____ Cultivar/Variety _____ Date Collected _____

2. Extension Agent _____ County _____ Phone ( ) _____
Grower _____ Address _____ Phone ( ) _____

3. *Briefly describe the symptoms and ask the specific question you want answered* _____

4. Do you want a control recommendation for ❑Home lawn/garden ❑Commercial production ❑ Lawn/landscape management ❑ other

Plant Part Affected	*General Appearance*	*Disease Distribution*	*Location*	
❑ roots	❑ wilted	❑ general	❑ field/farm	❑ golf course
❑ crown	❑ yellowed	❑ scattered plants	❑ garden	❑ sod farm
❑ stem or branch	❑ stunted	❑ in spots or groups	❑ landscape	❑ Christmas tree farm
❑ leaves	❑ stained/streaked	❑ certain cultivar	❑ nursery	❑ vineyard
❑ flower	❑ leaf spot/blight	❑ in low areas	❑ greenhouse	❑ orchard
❑ fruit	❑ leaf mottle	❑ upland areas	❑ athletic field	❑ forest
❑ seeds	❑ other_____	❑ other_____	❑ other_____	❑ indoor plant

5. *Size of total planting:* Acres _____ *or square feet* _____ *or number of plants* _____
Percent of crop affected _____ or number of plants affected _____
Last year's crop _____ Crop planned for next year _____
Symptoms first noticed, date _____ Occurrence in previous years: ❑ No ❑ Yes ❑ Unknown

6. Past weather conditions: ❑ normal ❑ rainy ❑ dry ❑ hot ❑ cold other _____
Have plants been irrigated? ❑yes ❑no how much? _____

7. SOIL:

Type	*Terrain*	*Drainage*	*Soil-less*	*Mulch*
❑ sandy	❑ sloped	❑ good	❑ pinebark	❑ bark chips
❑ clay	❑ level	❑ moderate	❑ peat moss	❑ plastic
❑ loam	❑ low	❑ poor	❑ other _____	❑ other _____

❑ no till _____ ❑ conventional till _____ ❑ minimal till

8. Nematode assay, date _____
Last soil test, date _____
Last lime application, date _____

9. *Chemicals and/or pesticides applied, **including method of application, rate and date:***
Growth regulator _____ ❑ none ❑ unknown
Fertilizer _____ ❑ none ❑ unknown
Fungicide _____ ❑ none ❑ unknown
Insecticide _____ ❑ none ❑ unknown
Herbicide _____ ❑ none ❑ unknown
Herbicide previous year _____ ❑ none ❑ unknown
Nematicide _____ ❑ none ❑ unknown
Nematicide previous year _____ ❑ none ❑ unknown

10. ***WOODY PLANTS ONLY***
Fruit trees and grapes: root stock _____ ❑ fruit bearing age ❑ nonbearing age
Trees, shrubs, fruit trees, and vines: approximate age _____ height _____ stem diameter _____
Canopy: ❑ few or no dead limbs ❑ 20-50% dead limbs ❑ 50% or more dead limbs
Number of years in present site: ❑ less than 2 ❑ less than 4 ❑ less than 10 ❑ greater than 10
Exposure: ❑ full sun ❑ partial sun ❑ full shade ❑ windy ❑ protected
Condition of trunk: ❑ healthy ❑ light damage ❑ heavy damage Describe: _____
❑ *Root damage or soil disturbance from any of the following: sidewalks, driveways, trenches, retaining walls, compaction, or other construction activities. Describe:* _____

DO NOT WRITE BELOW THIS LINE

DIAGNOSIS AND CONTROL Date received _____

Common Name _____ Scientific Name: _____

Comments: ❑ fungus ❑ bacterium ❑ virus ❑ nematode ❑ abiotic ❑ other

APPENDIX

SEVEN

Frequently Asked Questions about Soybean Rust

How likely are we to face an outbreak of soybean rust in 2004?
The arrival of *Phakopsora pachyrhizi*, the fungus that causes soybean rust, becomes more likely each year as reports of its occurrence in northern Brazil become more frequent. Although not officially north of the equator in South America, more effort is now in place to detect it in northern South America and Central America.

The entrance point is expected to be somewhere in the gulf or east coast states based on historical weather patterns that would bring spores through air currents primarily from northern coastal regions of South America, Central America and the Caribbean.

Epidemiologists working on the natural spread of rust think that the entry via hurricane activity from South or Central America or the Caribbean is likely. Monitoring the northern movement of the pathogen is critical to follow its movement towards the U.S. and could come quickly by tropical storms or more slowly through the Central American land bridge to a southern U.S. state.

Opinion varies on the time required for soybean rust to reach its potential range throughout the U.S., but it could take one season or several years although each year may differ as the pathogen will not over season in temperate areas unless it is kept inside on soybean plants in the greenhouse.

What areas of the U.S. are most at-risk to yield losses from soybean rust?
All soybean-growing areas of the U.S. are at risk with the most favorable weather conditions based on 30 year averages in the Mid-Atlantic and eastern Corn Belt states. In general, southern growing areas are at greater risk than northern areas, because of the longer growing season, the warm, humid climate that is favorable for rust development, and the presence of other hosts such as kudzu. Late-planted soybeans, such as those planted after small grain are at a higher risk since there is more time for inoculum buildup preceding this crop's entry into reproductive phases.

Risk analyses indicate that *P. pachyrhizi* could cause yield losses of greater than 10% in any U.S. soybean-growing region; while in southeastern coastal states losses up to 50% are possible. Of course this is all dependent on weather conditions during the growing season and the actually point where the pathogen enters the country.

Will soybean rust overwinter in Virginia?
Not likely, as the main infective spore of soybean rust, the urediniospore, and it cannot survive temperate conditions since there is no living host to survive on. Areas that are likely to support year-round occurrence of *P. pachyrhizi* are the southern parts of the very southernmost United

States and further south of the U.S. where freezing temperatures are rare. The presence of kudzu and several other hosts in those southernmost areas would create conditions for the rust fungus to become established.

Are imports of soybean meal, planting seed or whole soybeans likely to introduce rust to the U.S.?
No, the fungus is not seed borne. There is a very slight chance that spores could be associated with debris in seed. Research is ongoing to determine the influence of storage time and temperature on the survivability of rust spores. For meal there is virtually no chance of contamination since both the meal and the foreign material it contained were heat-treated, eliminating the risk that rust spores could survive. The American Soybean Association (ASA) has worked closely with the U.S. Animal and Plant Health Inspection Service (APHIS) to reduce the risk of accidental introduction of rust.

Are fungicides effective against soybean rust?
Yes, there are effective fungicides in use in other countries. If soybean rust arrives in the U.S., fungicides will be the major tool to protect yield.

In addition to efficacy, there are other important questions being addressed in current USDA-ARS fungicide trials in Africa and South America: application methods, the effect of fungicides on the crop, timing, minimum number of applications, and effective rates for each compound, as well as the economics of using fungicides on soybeans. The rust fungus is a highly variable pathogen, and resistance management may be an issue.

Will there be enough fungicide available to treat all my acres?
It depends when the rust pathogen arrives and on the extent of the outbreak. Section 18 Emergency Quarantine Exemption requests have already been drafted in order to expand the number of fungicides available if needed. Each season without the introduction of rust allows for additional fungicides to be evaluated, registered and manufactured, and provides time for the development of resistant soybean varieties. Once approved, the Section 18 Emergency Quarantine Exemption will be activated when *Phakopsora pachyrhizi* is confirmed in the continental United States.

When will varieties be available that are genetically resistant to soybean rust?
Best estimates say at least 4 or 6 years. The good news is that much groundwork has been done. Partial resistance or tolerance is likely to be the most effective resistance strategy, in which fewer lesions with a reduced number of spores develop. Planting cultivars with resistance to rust pathogens has been very successful in managing rust in wheat and corn, and is expected to be a successful approach with soybean rust.

How are my soybean checkoff dollars being used to help find solutions to this problem?
The Virginia Soybean Board has committed funds to provide for a soybean rust monitoring program during the 2004 growing season. The United Soybean Board has funded research on rust movement and occurrence, and research on soybean resistance and the screening of commercial soybean varieties. Soybean checkoff dollars have funded much of the information on rust available to soybean growers. State and National Associations have been at the forefront of

preventing accidental introduction of rust into the U.S., promoting federal funding for research, and encouraging the EPA and chemical companies to work on the availability of fungicides.

What is being done to monitor the movement of soybean rust in South America?
Air traps have been set up and molecular identification techniques are being used to distinguish the aggressive rust species from the mild one. At this time, the aggressive rust species has not been confirmed north of the equator in South America. In the U.S., the Florida Department of Agriculture has had a detection and surveillance program in place since February 2003 for soybean and kudzu. This program is now expanding into other southern states.

Is there anything I can do now to prepare for soybean rust?
Continue to stay informed as you are now. If you suspect soybean rust is present in your fields this season, contact your local county extension office, a certified crop advisor, or one of Virginia's Primary Diagnostic Centers. Any of these resource people will be able to determine if it could be rust, or another soybean foliar disease. If rust is suspected, the samples will be shipped for a second level of testing by the USDA-APHIS National Mycologist. This is to determine the type of rust, mild or aggressive.

What does the disease look like?

The most common symptom of *Phakopsora pachyrhizi* is tan to dark brown or reddish brown lesions. The disease begins as a yellow mosaic discoloration on the undersides of lower leaves of plants at or near flowering. Later, small, water-soaked lesions arise, gradually increase in size, and turn from gray to tan or brown. They assume a polygonal shape restricted by leaf veins and usually coalesce to form larger lesions. The lesions are slightly raised and consist of small pustules, with a small hole on top from which spores emerge. The pustules become more numerous and eventually coalesce to form larger pustules that break open, releasing masses of spores. Lesions can appear on petioles, pods, and stems but are most abundant on leaves, particularly on the underside of the leaf. See Appendix ONE for a visual description.

As the plant matures and sets pods, the symptoms spread rapidly to the middle and upper parts of the plant. Lesions are found on petioles, pods, and stems but are most abundant on leaves.

Especially at the early stages, it is easy to confuse the symptoms of soybean rust with symptoms of three other soybean leaf diseases: **brown spot** caused by the fungus, *Septoria glycines*, **bacterial pustule**, caused by *Xanthomonas axonopodis pv. glycine*s, and **bacterial blight** (also called **angular leaf spot**), caused by *Pseudomonas savastanoi pv. glycinea*.

How does this disease affect soybean?

Asian soybean rust is an aggressive disease that destroys photosynthetic tissue, causing premature defoliation, early maturation, and lower yields. The most severe epidemics occur when soybean leaves are infected early in the growing season, however leaves are susceptible at all stages of plant growth.

Does it affect any other crops grown in the Mid-Atlantic region?

Some common leguminous crop plants and weeds are also hosts, including kudzu (*Pueraria lobata*) yellow sweet clover (*Melilotus officinalis*), vetch (*Vicia dasycarpa*), medic (*Medicago*

arborea), lupine (*Lupinus hirsutus*), green and kidney bean (*Phaseolus vulgaris*), Lima and butter bean (*Phaseolus lunatus*).

Corn and other grain crops are not hosts to Asian soybean rust.

How far and how fast can we expect this disease to spread?

Soybean rust dispersal is highly dependent on environmental conditions. Once the pathogen is present, abundant spore production occurs during wet leaf periods of at least 8 hours (including extended dew periods) and moderate temperatures of 60 to 80°F. The spread of the disease within a field can occur quickly. Long-distance dispersal is dependent on wind patterns and weather conditions and is the subject of current research.

When should I start scouting for soybean rust?

The timing of scouting will depend on your geographic location within the United States and development stage of the crop. Southern growing areas will need to begin scouting before their counterparts in more northern growing areas because of where Asian soybean rust is expected to overwinter. Soybean rust expresses itself more after the crop enters into reproductive stages; therefore scouting should begin soon after flowering.

Soybean producers using an Early Soybean Production System (early-maturing varieties planted in April) should begin scouting in June when flowering begins. For May-planted and traditionally-used maturity groups, begin scouting in early-July and continue through mid-September. For double-crop soybeans, begin scouting after flowering (late-July to August, depending on maturity group).

Check the undersides of the lower leaves for a yellow mosaic discoloration and reddish-brown to tan pustules when leaflets are well developed. Especially check lower leaves of plants growing in low areas or along roads and streams where leaves tend to stay wet longer than in other places in the field. Check for lesions or yellowing, later for powdery, pale brown pustules that contain the urediniospores. As the plants start to flower, the infection moves up the plant as the lower leaves die and drop off.

When should we start to spray the disease once it is found in our area?

If the disease is confirmed and environmental conditions are favorable, probably at flowering (R1 or R2 stage). The second application, if needed, should be applied 20 days later.

How many times do we need to spray in a season?

Based on current research, soybean producers will likely need to apply two to three applications of a fungicide to obtain optimal results. In Brazil during the 2003-2004 season, it was estimated that 95% of the acreage was treated with between 1½ to 2 sprays. Short-season varieties only required one spray, while long-season varieties needed 2-3 applications.

How long will it take for the rust move from the south to the north?

Opinion varies on the time it will require for Asian soybean rust to reach its potential range after the initial introduction into the United States. It could take one season or several years.

Once established in the southernmost areas of the U.S., the spread of rust from south to north will be different each year. The movement will depend on the amount of inoculum that overwinters in the south each year and on spring weather conditions.

Can the introduction of soybean rust be an act of agro-terrorism?

Yes, but this method of introduction is less likely than wind dispersal. The spread of soybean rust through Africa and South America has been a natural event. There is no evidence of intentional introduction by humans.

Could dispersal have been prevented? How?

No. As more land was planted into soybean around the world, the spread of soybean rust eventually came with it.

What will this mean for Virginia's soybean crop after soybean rust arrives?

Yield losses can be managed but not totally eliminated. If conditions are favorable for the disease, yield losses of 10% or more may be expected. Dry conditions will lessen the impact. Cost of production will increase with fungicide application. Therefore soybean profitability may decrease.

What steps will the state take to protect people and the environment in the rush to spray soybean fields with pesticides?

Close monitoring of environmental conditions (temperature and moisture) and the presence of *P. pachyrhizi* will provide the information needed to make informed decisions about treatment. These forecasting models are being developed, as well as communication plans, so that timely treatments can be made and unneeded sprays prevented. In addition, there will be an individual scouting for soybean rust throughout Virginia's soybean growing regions.

Will insurance cover the losses caused by soybean rust?

When a producer is insured and follows good farming practices (including rust control measures), losses attributed to disease, including Asian Soybean Rust, are often insurable. Soybean producers should verify their coverage with their insurance provider.

If found in continental US, but not yet in Virginia, will Virginia researchers be allowed to bring rust into Virginia for research? … And finally, once confirmed in Virginia, will researchers be allowed to import rust for research in Virginia?

The answers to these questions are unknown at this time. Both USDA and VDACS must answer together. Answer will likely vary with state. The status of soybean rust as a Department of Homeland Security Select Agent will also affect this.

APPENDIX

EIGHT

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APPENDIX

NINE

USDA-APHIS information on *Phakopsora pachyrhizi*.

The USDA-APHIS information can be found at:

http://www.aphis.usda.gov/ppq/ep/soybean_rust/

www.aphis.usda.gov/ppq/ep/soybean_rust/UreMelPp502.pdf